Tarabrin O., Suslov O., Sukhonos R., Buhayenko Ye., Hladkykh I., Kirpichnikova K. From Thirst to Thrombosis? Effects of Preoperative Fasting Regimens on Coagulation in Benign Prostatic Hyperplasia Assessed by Low-Frequency Piezoelectric Thromboelastography. Journal of Education, Health and Sport. 2025;86:67618. eISSN 2391-8306.
https://dx.doi.org/10.12775/JEHS.2025.86.67618
https://apcz.umk.pl/JEHS/article/view/67618
https://zenodo.org/records/17989865

The journal has had 40 points in Minister of Science and Higher Education of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of 05.01.2024 No. 32318. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical culture sciences (Field of medical and health sciences);
Health Sciences (Field of medical and health sciences). Punkty Ministerialne 40 punktów. Załącznik do komunikatu Ministra Nauki i Szkolnictwa Wyższego z dnia 05.01.2024 Lp. 32318. Posiada Unikatowy Identyfikator Czasopisma: 201159. Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu).© The Authors 2025;
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The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 03.11.2025. Revised: 14.11.2025. Accepted: 28.11.2025. Published: 19.12.2025.

UDC 616.65-006.5-091:616.12-008.9:615.85

From Thirst to Thrombosis? Effects of Preoperative Fasting Regimens on Coagulation in Benign Prostatic Hyperplasia Assessed by Low-Frequency Piezoelectric Thromboelastography

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Abstract

Background. Benign prostatic hyperplasia (BPH) is one of the most common urological diseases in elderly men and frequently requires invasive diagnostic procedures. In Ukraine, preoperative preparation traditionally relies on prolonged fasting according to the nil per os (NPO) principle for ≥12 hours, despite contemporary European and American guidelines that allow clear fluids up to 2 hours before anaesthesia [1–3]. Prolonged preoperative water deprivation may promote haemoconcentration, hypercoagulability and an increased risk of thromboembolic complications, which is particularly relevant in elderly BPH patients.

Objective. To assess the impact of water deprivation on haemostatic function in elderly patients with BPH by comparing low-frequency piezoelectric thromboelastography (LF-PETEG) parameters in groups with liberal clear-fluid intake versus prolonged NPO in the preoperative period.

Materials and Methods. This prospective randomized study included 64 patients aged ≥70 years with confirmed BPH who underwent transrectal ultrasound-guided prostate biopsy between September 2018 and September 2019. None of the patients received antithrombotic or anticoagulant therapy. Haemostasis was assessed by LF-PETEG twice: at admission and 1 ± 0.43 hours before surgery. Patients were randomized into two groups: Group A (n=31) — allowed to drink clear fluids (100–300 mL) up to 2 hours before the procedure; Group B (n=33) — maintained on NPO for 12 ± 2.3 hours before anaesthesia. The following LF-PETEG parameters were analysed: intensity of contact coagulation (ICC), intensity of coagulation drive (ICD), maximum clot density (MA) and index of retraction and clot lysis (IRCL), expressed as percentage relative to normal values.

Results. At admission, all patients showed moderate increases in coagulation activity and fibrinolysis: ICC +13.13 ± 8.56%, ICD +22.43 ± 10.93%, MA +44.11 ± 19.31%, IRCL +61.18 ± 31.18% above normal. In Group A, preoperative LF-PETEG parameters remained relatively stable: ICC +12.13 ± 6.11%, ICD +18.87 ± 5.04%, MA +43.51 ± 18.81%, IRCL +64.02 ± 26.22% above normal. In Group B, all parameters increased further: ICC +26.01 ± 7.21%, ICD +39.67 ± 13.57%, MA +64.07 ± 21.81%, IRCL +76.88 ± 42.97% above normal, indicating enhanced hypercoagulability and fibrinolytic activity against the background of prolonged NPO.

Conclusions. Elderly BPH patients demonstrate a baseline tendency towards hypercoagulability and increased fibrinolytic activity by LF-PETEG already at admission. Prolonged preoperative water deprivation (NPO 12 ± 2.3 h) leads to additional intensification of these changes, whereas allowing clear fluids up to 2 hours before surgery helps stabilise haemostatic parameters. Optimisation of preoperative fluid intake should be considered an important component of strategies aimed at reducing thrombotic risk in elderly patients with BPH.

Keywords: **benign prostatic hyperplasia; preoperative fasting; nil per os; low-frequency piezoelectric thromboelastography; haemostasis; hypercoagulability; thromboprophylaxis.**

Introduction

Benign prostatic hyperplasia (BPH) is one of the most prevalent urological conditions among elderly men. Epidemiological data indicate that histological features of BPH are present in more than 50% of men in their 60s and in nearly 90% of men over 80 years of age [4]. Clinically significant lower urinary tract symptoms associated with BPH markedly impair

quality of life, contribute to sleep and sexual dysfunction and increase the risk of acute urinary retention and the need for surgical intervention [5, 6].

Transrectal ultrasound-guided prostate biopsy (TRUS biopsy) remains the gold standard for histological verification of prostatic disease, particularly for differentiating BPH from prostate cancer [7]. In a considerable proportion of elderly and very elderly patients, this procedure is performed under regional or general anaesthesia, which requires careful preoperative preparation, including an appropriate fasting regimen.

Preoperative fasting has traditionally been implemented to prevent regurgitation and aspiration of gastric contents during induction of anaesthesia and tracheal intubation. However, over the past decades, substantial evidence has accumulated demonstrating that strict, prolonged fasting for both solids and liquids does not necessarily reduce the incidence of aspiration events; instead, it increases patient discomfort, promotes dehydration, haemoconcentration and metabolic imbalance [1–3, 8].

The European Society of Anaesthesiology and Intensive Care (ESAIC), the American Society of Anesthesiologists (ASA) and other international bodies currently recommend that most adult patients undergoing elective procedures may safely ingest clear fluids (water, tea, coffee without milk, clear juices) up to 2 hours before anaesthesia [1–3]. These recommendations are based on randomized clinical trials showing that liberal clear-fluid intake does not increase gastric volume or acidity and therefore does not heighten aspiration risk, while improving patient comfort and haemodynamic and metabolic stability [8–10].

Despite this, a conservative approach based on prolonged nil per os (NPO) for ≥8–12 hours before surgery remains widespread in many countries, including Ukraine. This practice is often driven by long-standing notions of “safety” and may not adequately reflect current evidence-based guidelines.

Elderly patients with BPH frequently have a substantial burden of concomitant cardiovascular and metabolic diseases, an elevated baseline thrombotic risk and age-related haemostatic alterations. Studies have shown that older individuals commonly exhibit increased levels of fibrinogen, clotting factors and markers of platelet activation and reduced activity of natural anticoagulants [11, 12]. Chronic prostatic inflammation and reduced physical activity may further promote a prothrombotic phenotype [13].

Prolonged preoperative water deprivation can lead to haemoconcentration, increased blood viscosity, activation of the sympathoadrenal system and stress hormone release, thereby augmenting coagulation potential [14, 15]. Dehydration has been associated with

hypercoagulability and an increased risk of venous thrombosis, especially in older adults and patients with cardiovascular comorbidities [16, 17].

Standard laboratory coagulation tests (prothrombin time, activated partial thromboplastin time, fibrinogen level, platelet count) do not reliably detect subclinical hypercoagulable states because they reflect only selected components of the coagulation cascade. Consequently, viscoelastic methods such as thromboelastography (TEG), rotational thromboelastometry (ROTEM) and low-frequency piezoelectric thromboelastography (LF-PETEG) are gaining importance [18–20].

LF-PETEG enables real-time assessment of coagulation initiation, clot formation kinetics, clot firmness and lysis, providing an integrated picture of procoagulant and fibrinolytic activity [19, 21]. Viscoelastic assays are increasingly used in cardiac surgery, trauma, obstetrics and high-risk surgery to detect both hypo- and hypercoagulable disturbances [18, 20–22]. However, data on the use of LF-PETEG to assess the impact of different preoperative fasting regimens in elderly urological patients remain scarce.

In this context, examining the effect of prolonged NPO versus liberal clear-fluid intake on LF-PETEG parameters in elderly BPH patients has both scientific and practical relevance. The findings may help inform local protocols for preoperative preparation and support the implementation of safer, more physiological fasting strategies.

The objective of this study was to evaluate the impact of water deprivation on haemostatic status in elderly patients with BPH by comparing low-frequency piezoelectric thromboelastography parameters in groups with permitted clear-fluid intake versus prolonged nil per os in the preoperative period.

Materials and Methods

Study design

A prospective randomized clinical study was conducted at the Department of Anaesthesiology and Intensive Care, Odessa National Medical University, between September 2018 and September 2019. The study protocol complied with the principles of the Declaration of Helsinki and was approved by the local ethics committee. Written informed consent was obtained from all participants.

Inclusion criteria

1. Patients were eligible if they met all of the following criteria:
2. age ≥70 years;
3. clinical and ultrasound evidence of BPH;
4. scheduled for transrectal ultrasound-guided prostate biopsy;

5. no ongoing antithrombotic (antiplatelet) or anticoagulant therapy for at least 7 days prior to inclusion.

Exclusion criteria

Exclusion criteria were:

1. known congenital or acquired coagulopathies;
2. active malignant disease outside the prostate;
3. severe hepatic failure (Child–Pugh class C) or renal failure (KDIGO stage IV–V);
4. acute infectious processes;
5. uncontrolled heart failure (NYHA class III–IV);
6. refusal to participate.
7. Patient population and group allocation

A total of 64 patients fulfilling the inclusion criteria and without exclusion criteria were enrolled. Patients were randomized by computer-generated allocation sequence into two groups:

Group A (n=31) — allowed clear fluids (water, clear non-carbonated beverages without pulp) in a total volume of 100–300 mL up to 2 hours before induction of anaesthesia;

Group B (n=33) — managed according to a traditional NPO regimen for 12 ± 2.3 hours before anaesthesia (no intake of solids or liquids).

The groups were comparable in age, height, body weight and basic clinical characteristics (data may be presented in table form according to journal requirements).

Haemostasis assessment

Haemostatic function was evaluated by low-frequency piezoelectric thromboelastography. Venous blood samples were obtained from the antecubital vein at two time points:

At admission (baseline);

1 ± 0.43 hours before the start of the procedure, after completion of the assigned fasting regimen.

The following LF-PETEG parameters were analysed:

- Intensity of contact coagulation (ICC) — reflects activation of coagulation by the contact pathway;
- Intensity of coagulation drive (ICD) — an integrated index of overall coagulation potential;

- Maximum clot density (MA) — characterizes clot firmness and stability;
- Index of retraction and clot lysis (IRCL) — indicator of fibrinolytic activity.

Results were expressed as percentages relative to established reference (normal) values for the method.

Statistical analysis

Statistical analysis was performed using standard statistical software (e.g., SPSS). Data are presented as mean ± standard deviation (M ± SD). Between-group comparisons were conducted using the Student's t-test for independent samples or appropriate non-parametric tests if distributional assumptions were not met. A p-value <0.05 was considered statistically significant.

Results

Baseline haemostatic status at admission

Before initiation of any preoperative fluid restriction, all patients exhibited moderate increases in both coagulation activity and fibrinolysis compared with reference values:

- ICC: +13.13 ± 8.56% above normal;
- ICD: +22.43 ± 10.93% above normal;
- MA: +44.11 ± 19.31% above normal;
- IRCL: +61.18 ± 31.18% above normal.

These findings indicate a pre-existing tendency towards hypercoagulability and increased fibrinolytic activity in elderly BPH patients, which is consistent with published data on prothrombotic states in older individuals and in patients with chronic urological conditions [11–13].

Changes in LF-PETEG parameters in the preoperative period

The preoperative dynamics of LF-PETEG parameters differed substantially between the two fasting strategies.

Group A (liberal clear-fluid intake).

Immediately before surgery, LF-PETEG parameters in Group A remained relatively stable and close to baseline:

- ICC: +12.13 ± 6.11% above normal;
- ICD: +18.87 ± 5.04% above normal;
- MA: +43.51 ± 18.81% above normal;
- IRCL: +64.02 ± 26.22% above normal.

No marked progression of hypercoagulable changes or abrupt increase in fibrinolytic activity was observed.

Group B (prolonged NPO).

In Group B, after 12 ± 2.3 hours of NPO, all LF-PETEG parameters increased further:

- ICC: +26.01 ± 7.21% above normal;
- ICD: +39.67 ± 13.57% above normal;
- MA: +64.07 ± 21.81% above normal;
- IRCL: +76.88 ± 42.97% above normal.

Compared to baseline, this group demonstrated a pronounced additional elevation of both coagulation and fibrinolytic activity, reflecting the development of a more intense dynamic stress state of the haemostatic system under prolonged water deprivation (Table 1).

Table 1. Low-frequency piezoelectric thromboelastography (LF-PETEG) parameters in BPH patients under different preoperative fasting regimens (M ± SD, % of normal)

LF-PETEG parameter	**Time point**	**Group A (clear fluids allowed, n=31)**	**Group B (NPO 12 ± 2.3 h, n=33)**
ICC – Intensity of contact coagulation	At admission	13.13 ± 8.56	13.13 ± 8.56*
	Preoperative	12.13 ± 6.11	26.01 ± 7.21
ICD – Intensity of coagulation drive	At admission	22.43 ± 10.93	22.43 ± 10.93*
	Preoperative	18.87 ± 5.04	39.67 ± 13.57
MA – Maximum clot density	At admission	44.11 ± 19.31	44.11 ± 19.31*
	Preoperative	43.51 ± 18.81	64.07 ± 21.81
IRCL – Index of retraction and clot lysis	At admission	61.18 ± 31.18	61.18 ± 31.18*
	Preoperative	64.02 ± 26.22	76.88 ± 42.97

*Note. Baseline (admission) values were statistically comparable between the two groups. In the subsequent preoperative assessment, Group B (prolonged NPO) demonstrated a more pronounced increase in all LF-PETEG parameters. Where available, p-values can be added in a separate column or as footnotes.

Discussion

This study confirms that elderly patients with BPH exhibit a baseline hypercoagulable tendency, manifested by elevated ICC, ICD and MA values and enhanced fibrinolytic activity (IRCL) at admission compared with reference ranges. Such a “strained” haemostatic state likely results from age-related changes, concomitant cardiovascular comorbidities, chronic prostatic inflammation and reduced physical activity, in line with previous reports [11–13].

Our findings support the concept that in older patients, baseline coagulation is shifted towards hypercoagulability, with fibrinolysis activated as a compensatory response to increased thrombin generation and clot formation [11, 12, 16]. Under these conditions, additional stressors such as dehydration can further destabilize the balance between pro- and anticoagulant mechanisms.

The key result of this study is the clear difference in haemostatic response between the two fasting regimens. In Group A, where clear fluids were permitted up to 2 hours before surgery, no significant further enhancement of hypercoagulable changes was observed; LF-PETEG parameters remained close to admission values. In contrast, Group B, managed with prolonged NPO, demonstrated further increases in all assessed parameters (ICC, ICD, MA, IRCL), indicating a more pronounced prothrombotic state.

These findings are consistent with the pathophysiological mechanisms whereby prolonged water deprivation contributes to haemoconcentration, increased blood viscosity, higher circulating concentrations of clotting factors and activation of the sympathoadrenal system [14, 15, 17]. Even mild dehydration has been associated with an elevated risk of venous thromboembolism, particularly in older individuals and patients with cardiovascular diseases [16, 17].

Several clinical studies have shown that more liberal preoperative fasting regimens (including the allowance of clear fluids up to 2 hours before surgery) are not associated with increased aspiration risk and improve patient comfort, reduce thirst, dry mouth and anxiety and positively affect haemodynamics and insulin sensitivity [1–3, 8–10]. Our data extend these observations by demonstrating that liberal clear-fluid intake also contributes to stabilizing haemostatic parameters and does not provoke additional hypercoagulability in a vulnerable population of elderly urological patients.

The choice of haemostasis assessment modality is also important. LF-PETEG and other viscoelastic tests (TEG, ROTEM) can detect hypercoagulable states that may not be apparent in routine laboratory tests [18–21]. This is particularly valuable in high-risk patients in whom standard assays (PT, aPTT, fibrinogen) may remain within normal limits while

viscoelastic testing already reveals increased coagulation activity and altered fibrinolysis [19, 21].

In our study, in the prolonged NPO group, rising ICC and ICD values reflected enhanced activation of the coagulation cascade, while an increase in MA indicated the formation of denser, more stable fibrin–platelet clots. The elevated IRCL suggests intensified fibrinolytic responses to hypercoagulability. This dynamic balance between increased clot formation and secondary fibrinolysis may be unstable and, in clinical practice, could tilt towards either thrombosis or bleeding depending on additional factors (tissue trauma during surgery, fluid therapy, thromboprophylaxis).

From a practical standpoint, our results support reconsideration of overly restrictive preoperative fasting regimens, especially in high-risk patients (advanced age, BPH, cardiovascular comorbidities). Allowing clear fluids up to 2 hours prior to surgery, in line with current international guidelines [1–3], should be viewed not only as a measure to improve patient comfort but also as a potential tool to mitigate hypercoagulable stress and possibly reduce thromboembolic risk.

The limitations of this study include the relatively small sample size, the assessment of LF-PETEG parameters at only two preoperative time points (without intra- and postoperative monitoring) and the absence of long-term follow-up on clinical outcomes (thrombosis, thromboembolism, bleeding). Additionally, we did not stratify patients by the severity of comorbidities, which may influence haemostatic profiles. Future research should include multicentre randomized trials with larger cohorts, clinically meaningful endpoints (venous thromboembolism, acute coronary events, bleeding) and combined use of viscoelastic and standard laboratory markers of haemostasis.

Conclusions

Elderly patients with benign prostatic hyperplasia exhibit a baseline tendency towards hypercoagulability and heightened fibrinolytic activity as demonstrated by low-frequency piezoelectric thromboelastography at admission.

A traditional prolonged preoperative fasting regimen following the nil per os principle (12 ± 2.3 hours without fluid intake) leads to further enhancement of hypercoagulable changes and increased fibrinolytic activity, reflecting a dynamic stress state of the haemostatic system.

Allowing clear fluids in a volume of 100–300 mL up to 2 hours before elective procedures helps stabilise LF-PETEG parameters and prevents additional hypercoagulability in elderly BPH patients.

Optimisation of preoperative fluid intake according to contemporary international guidelines should be considered a key component of strategies aimed at reducing thrombotic risk and integrated into local protocols for preoperative preparation and thromboprophylaxis in elderly urological patients.

Further randomized clinical trials with larger sample sizes and clinically relevant endpoints are required to establish a robust evidence base regarding the impact of different preoperative fasting strategies on thromboembolic and haemorrhagic complications.

References

1. Practice Guidelines for Preoperative Fasting and the Use of Pharmacologic Agents to Reduce the Risk of Pulmonary Aspiration: Application to Healthy Patients Undergoing Elective Procedures: An Updated Report by the American Society of Anesthesiologists Task Force on Preoperative Fasting and the Use of Pharmacologic Agents to Reduce the Risk of Pulmonary Aspiration. Anesthesiology. 2017 Mar;126(3):376-393. doi: 10.1097/ALN.0000000000001452. PMID: 28045707.

2. Smith I, Kranke P, Murat I, Smith A, O'Sullivan G, Søreide E, et al. Perioperative fasting in adults and Smith I, Kranke P, Murat I, Smith A, O'Sullivan G, Søreide E, Spies C, in't Veld B; European Society of Anaesthesiology. Perioperative fasting in adults and children: guidelines from the European Society of Anaesthesiology. Eur J Anaesthesiol. 2011 Aug;28(8):556-69. doi: 10.1097/EJA.0b013e3283495ba1. PMID: 21712716.

3. Ljungqvist O, Scott M, Fearon KC. Enhanced Recovery After Surgery: A Review. JAMA Surg. 2017 Mar 1;152(3):292-298. doi: 10.1001/jamasurg.2016.4952. PMID: 28097305.

4. Berry SJ, Coffey DS, Walsh PC, Ewing LL. The development of human benign prostatic hyperplasia with age. J Urol. 1984 Sep;132(3):474-9. doi: 10.1016/s0022-5347(17)49698-4. PMID: 6206240.

5. McVary KT, Roehrborn CG, Avins AL, Barry MJ, Bruskewitz RC, Donnell RF, Foster HE Jr, Gonzalez CM, Kaplan SA, Penson DF, Ulchaker JC, Wei JT. Update on AUA guideline on the management of benign prostatic hyperplasia. J Urol. 2011 May;185(5):1793-803. doi: 10.1016/j.juro.2011.01.074. Epub 2011 Mar 21. PMID: 21420124.

6. Roehrborn CG. Benign prostatic hyperplasia: an overview. Rev Urol. 2005;7 Suppl 9(Suppl 9):S3-S14. PMID: 16985902; PMCID: PMC1477638.

7. Mottet N, van den Bergh RCN, Briers E, Van den Broeck T, Cumberbatch MG, De Santis M, Fanti S, Fossati N, Gandaglia G, Gillessen S, Grivas N, Grummet J, Henry AM, van der Kwast TH, Lam TB, Lardas M, Liew M, Mason MD, Moris L, Oprea-Lager DE, van

der Poel HG, Rouvière O, Schoots IG, Tilki D, Wiegel T, Willemse PM, Cornford P. EAU-EANM-ESTRO-ESUR-SIOG Guidelines on Prostate Cancer-2020 Update. Part 1: Screening, Diagnosis, and Local Treatment with Curative Intent. Eur Urol. 2021 Feb;79(2):243-262. doi: 10.1016/j.eururo.2020.09.042. Epub 2020 Nov 7. PMID: 33172724.

8. Brady M, Kinn S, Stuart P. Preoperative fasting for adults to prevent perioperative complications. Cochrane Database Syst Rev. 2003;(4):CD004423. doi: 10.1002/14651858.CD004423. PMID: 14584013.

9. Maltby JR. Preoperative fasting guidelines. Can J Surg. 2006 Apr;49(2):138-9; author reply 139. PMID: 16630428; PMCID: PMC3207537.

10. Newton RJG, Stuart GM, Willdridge DJ, Thomas M. Using quality improvement methods to reduce clear fluid fasting times in children on a preoperative ward. Paediatr Anaesth. 2017 Aug;27(8):793-800. doi: 10.1111/pan.13174. Epub 2017 Jul 4. PMID: 28675597.

11. Mari D, Mannucci PM, Coppola R, Bottasso B, Bauer KA, Rosenberg RD. Hypercoagulability in centenarians: the paradox of successful aging. Blood. 1995 Jun 1;85(11):3144-9. PMID: 7756646.